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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

Application Number: 10/798,456
Filing Date: March 10, 2004
Appellant(s): CHOI ET AL.

MAILED
JUN 27 2007
GROUP 1700

Marc S. Hanish
For Appellant

EXAMINER'S ANSWER

This is in response to the appeal brief filed 2/15/2007 appealing from the Office action mailed 8/24/2006.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is substantially correct. Note: in section A. "The rejection of claims 1, 2, 4-7, 13, 14, and 18-20 under 35 U.S.C. 103(a) as **being anticipated** by Naeem et al. (US 5,846,884) in view of Hineman et al. (US 6,379,872 B1)" is clearly not be anticipated. Also, Claim 15, which is currently under section E and Claim 11 should both be included under section C.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

5,846,884	NAEEM	12-1998
6,379,872	HINEMAN	4-2002
6,080,622	CHEN	6-2000
6,316,167	ANGELOPOULOS	11-2001
6,217,786	HILLS	4-2001

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

A. Claims 1, 2, 4-7, 13, 14, and 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Naeem et al. (US 5,846,884) in view of Hineman et al. (US 6,379,872 B1).

Naeem discloses a method for etching through a selected portion of a layer stack (Abstract), which comprises interlayer dielectric layer **102**, barrier layer **104**, metallization layer **106**, barrier layers **108 and 110**, anti-reflective coating layer **112**, and photoresist layer **114**. The ARC layer **112** may be organic in nature (column 1, lines 20-57). Naeem also discloses, "In step **302**, etching is preformed . . . using . . . gases such as N₂, . . . O₂, CHF₃, CF₄, CO and/or other suitable chemistry (column 6, lines 13). Naeem further discloses vertical etching through layers **112, 110, 105, 104, and 102** (column 2, lines 31-33). Layer **102** is typically silicon dioxide (same as Appellants' inorganic dielectric layer), (column 1, lines 26-28). The aforementioned reads on,

A method for etching an inorganic dielectric layer through a photoresist mask with an ARC layer between the layer to be etched and the photoresist mask over a substrate, comprising:

placing the substrate into a processing chamber;

providing an ARC open gas mixture into the processing chamber, wherein the ARC open gas mixture comprises:

an etchant gas; and

a polymerization gas comprising CO and CH₃F;

forming an ARC open plasma from the ARC open gas mixture; etching the ARC layer with the ARC open plasma until the ARC layer is opened; and

etching the inorganic dielectric layer, **in claim 1**;

A method for forming a semiconductor device, comprising:

placing a layer to be etched over a substrate; forming an organic ARC layer over the layer to be etched; forming a photoresist mask over the ARC layer;

placing the substrate into a processing chamber;

providing an ARC open gas mixture into the processing chamber, wherein the ARC open gas mixture comprises:

an etchant gas; and

a polymerization gas comprising CO and CH₃F;

forming an ARC open plasma from the ARC open gas mixture;

etching the ARC layer with the ARC open plasma until the ARC layer is opened;

providing an etch plasma different than the ARC open plasma; and

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etching the inorganic layer to be etched with the etch plasma, **in claim 18**;

wherein the ARC open gas mixture further comprises an etch rate booster, wherein the etch rate booster is O₂, **in claims 4 and 19**;

wherein the layer to be etched is a dielectric layer and wherein the etchant gas comprises at least one of an N₂ and H₂ mixture and CF₄, **in claim 5 and 20**;

further comprising providing a photoresist mask over the stack, **in claim 7**; and

wherein the inorganic dielectric layer is silicon oxide (column 1, lines 26-28), **in claim 23 and 24**.

Naeem differs in failing to teach stopping the ARC open gas mixture before the inorganic dielectric layer to be etched is completely etched, **in claim 1**; and stopping the ARC open gas mixture, so that none of the layer to be etched is etched by the ARC open plasma, **in claim 18**.

Hineman teaches, "To provide a more uniform and predictable etch through the ARC 14, two plasma etching processes are performed sequentially . . . the first plasma etch process should be halted before etching of the ARC 14 is completed . . . In general it is desirable to use the first plasma etch to etch as much of the ARC 14 as possible, but to stop the first plasma etch process prior to any etching of the (underlying layer) layer 12" (column 3, lines 26-54).

Hineman illustrates stopping an ARC open gas mixture before the inorganic dielectric layer to be etched is completely etched, is known. Hence, it would have been obvious to one having ordinary skill in the art at the time the invention was made to

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modify Naeem by stopping the etching of an ARC open gas mixture for the purpose of uniformly etching through an ARC (Hineman, column 3, lines 26-27).

Since the combination of Naeem and Hineman teaches a similar method of etching the same materials as applicants, then using the said combination in the same manner as claimed by applicants would result the same wherein ARC open plasma highly selectively etches the ARC with respect to the layer to be etched, **as in claim 2.**

B. Claims 3 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Naeem (US '884) in view of Hineman (US '872 B1) as applied to claim 1 above, and further in view of Chen et al. (US 6,080,662).

Naeem in view of Hineman differ in failing to disclose wherein the flow rate of CO is at least 150 sccm, **in claims 3 and 12.**

Chen discloses, an etching process that uses 0-200 sccm of CO (Abstract).

Chen illustrates CO having a flow rate of at least 150 sccm is known. Hence, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify Naeem by selecting any flow rate of CO as taught in the Chen reference, including Appellants' claimed flow rate, which would effectively accomplish the disclosed composition in an etching method because it has been held that there is no invention where the difference in proportions is not critical and was ascertained by routine experimentation because the determination of workable ranges is not considered inventive. See *In re Swain and Adams*, 70 USPQ 412 (CPA 1946).

C. **NOTE: This is not a new ground of rejection because of an inadvertent error in omitting Claims 11 and 15 in the header on page 6 of the Office Action of 8/24/2006.**

Claims 8, 10, 11, and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Naeem (US '884) in view of Hineman (US '872 B1) as applied to claim 1 above, and further in view of Angelopoulos et al. (US 6,316,167 B1).

Naeem in view of Hineman differ in failing to teach wherein the ARC layer is of an organic material and wherein the photoresist mask is of a 193 or higher generation photoresist, **in claim 8**; and wherein the ARC layer is of an organic material and wherein the photoresist mask is of a 193 or higher generation photoresist and wherein the ARC open plasma etches the ARC with respect to the layer to be etched with a selectivity greater than 50:1, **in claims 10, 11, and 15.**

Angelopoulos discloses, "A broad aspect of the present invention is a resist structure comprising a resist on top of a vapor deposited RCHX film . . . wherein the optical and chemical properties of the RCHX films are tuned to (1) provide suitable optical properties at the appropriate wavelength (248 nm, 193 nm, 157 nm, 126 nm and extreme ultraviolet radiation) to function as an ARC (2) not negatively interact with the resist inducing residue, footing or undercutting and (3) provides good etch selectivity to the resist." (column 5, line 66 - column 6, line 10).

Angelopoulos also teaches using the RCHX film as a replacement to conventional bottom ARC in a conventional stack as shown in FIG. 11 (column 7, lines 24-26).

Angelopoulos illustrates an ARC of an organic material having a photoresist mask of 193 nm or higher and the layer to be etching is silicon oxide is known.

Hence, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify Naeem in view of Hineman by using an ARC of an organic material having a photoresist mask of 193 nm or higher and the layer to be etching is silicon oxide for the purpose of providing good etch selectivity to the resist (Angelopoulos, column 6, line 5-10).

Since the combination of Naeem in view of Hineman and further in view of Angelopoulos teaches a similar method of etching as claimed by Appellants, then using the said combination in the same manner as the claimed invention would result the same wherein the ARC open plasma etches the ARC with respect to the layer to be etched with a selectivity greater than 50:1.

D. Claims 21, 22, 25, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Naeem (US '884) in view of Hineman et al. (US '872 B1). , as applied to claims 1, 2, 4-7, 13, 14, and 18-20, above, and further in view of Hills et al. (US 6,217,786 B1).

Naeem in view of Hineman differs in failing to teach providing power of 0-1000 Watts at 27 MHz and 100-1000 Watts at 2MHz, **in claim 21;**

wherein the temperature within said chamber is between -20 and 40°C, **in claim 22;** and

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setting the pressure within said processing chamber at between 200 and 300 mTorr, in claims 25 and 26.

Hills discloses, "Exemplary Etching Parameters: Approximate Range Parameters Electrostatic Chuck (-20)-(40) °C., 20 °C. Temperature: Top Electrode Temperature: 0-60°C. 40 °C. Bottom Power (2 MHz) 0-2500 watts 2200 W Top Power (27 MHz) 0-2500 watts 1200 W ESC He Pressure 5-30 Torr 15 Torr Chamber Pressure 10-250 mTorr 67 mTorr Electrode Gap 1-4 cm 1.3 cm Top Electrode Frequency 13-40 MHz 27 MHz Bottom Electrode Frequency 1-4 MHz 2 MHz " (column 6, lines 16-54), which reads on Appellants' specific process parameters as recited in the claims.

Hills illustrates Appellants' specific process parameters are known.

Hence it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify Naeem in view of Hineman by using Hills's process parameters for the purpose of achieving a substantially straight vertical profile of an opening in an oxide layer while maintaining critical dimension control (Hills, column 3, lines 36-41).

(10) Response to Argument

A. Claims 1, 2, 4-7, 13, 14, and 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Naeem et al. (US 5,846,884) in view of Hineman et al. (US 6,379,872 B1).

Appellants traverse the rejection of claim 1, 2, 4-7, 13, 14, and 18-20 over Naeem in view of Hineman as making new grounds of rejection in the Final Office

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Action mailed August 24, 2006. Appellants argue the former prior art of record failed to address etching an inorganic dielectric layer, as recited in (Currently Amended) Claims 1 and 18; the Final Office Action merely repeats the exact same rejection using the exact same prior art and fails to address the arguments made in the amendment or identify where in the (old) prior art the newly added elements can be allegedly found.

Appellants' argument is unpersuasive and a new grounds of rejection was proper to address etching an --inorganic dielectric--, which was not originally present in the claims. The new ground of rejection of claims 1 and 18 were addressed in the Naeem reference, which discloses a method for etching through a selected portion of a layer stack (Abstract), which comprises interlayer dielectric layer **102**, barrier layer **104**, metallization layer **106**, barrier layers **108 and 110**, anti-reflective coating layer **112**, and photoresist layer **114**. Naeem also discloses, vertical etching through layers **112, 110, 105, 104, and 102** (column 2, lines 31-33) and layer **102** is typically silicon dioxide (same as Appellants' inorganic dielectric layer), (column 1, lines 26-28).

Appellants argue the combination of Naeem and Hineman fails to teach, "etching the inorganic dielectric layer", in amended claim 1 and "placing an inorganic dielectric layer to be etched over a substrate" or "etching the inorganic dielectric layer to be etched with the plasma, in amended claim 18.

Appellants' argument is unpersuasive because Naeem discloses, vertical etching through layers **112, 110, 105, 104, and 102** (column 2, lines 31-33) and layer **102** is typically silicon dioxide (same as Appellants' inorganic dielectric layer), (column 1, lines

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26-28). Naeem further discloses "In step 302, etching is preformed . . . using . . . gases such as N₂, . . . O₂, CHF₃, CF₄, CO and/or other suitable chemistry (column 6, lines 13). Naeem also discloses the etch process may be performed using any suitable etch technique, such as RIE (reactive ion etching), which uses a plasma reactor (column 5, lines 21-37).

Appellant further argue Naeem fails to teach or suggest protecting an inorganic dielectric during the etch.

With regards to a teaching or suggesting to protect an inorganic dielectric during the etch is not a feature that is required by the claim.

Appellants argue the claimed invention describes a method for etching an inorganic dielectric layer, which is a process that does not occur in Naeem until long after the invention process in Naeem is completed.

Appellants' acknowledgement of etching dielectric layer, as shown in FIG 1B, is noted. However, Appellants argument is unpersuasive because the claimed invention does not required nor specifies a time at which etching the inorganic dielectric layer is to be completed.

Appellants argue Hineman teaches halting a first plasma etch process prior to completion of the ARC etch, but fails to use specialized gasses, pressure, or chamber

setting to help reduce or to eliminate the erosion of the substrate during the first plasma etch.

Appellants' argument is acknowledged but unpersuasive because Hineman teaches, "To provide a more uniform and predictable etch through the ARC 14, two plasma etching processes are performed sequentially . . . the first plasma etch process should be halted before etching of the ARC 14 is completed . . . In general it is desirable to use the first plasma etch to etch as much of the ARC 14 as possible, but to stop the first plasma etch process prior to any etching of the (underlying layer) layer 12" (column 3, lines 26-54). Hineman illustrates stopping an ARC open gas mixture before the inorganic dielectric layer to be etched is completely etched, is known. Hence, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify Naeem by stopping the etching of an ARC open gas mixture for the purpose of uniformly etching through an ARC (Hineman, column 3, lines 26-27). Hence, Hineman is relied upon solely to show stopping the ARC etch before the layer (inorganic dielectric) is completely etched.

Appellants further argue dependent claims 2, 4-7, 13, 14, and 19-20 are patentably distinct from the cited references for the same reasons as recited above in the independent claims.

Appellants' argument is acknowledged and unpersuasive for the reasons given above in reference to independent claims 1 and 18.

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B. Claim 3 and 12 are under 35 U.S.C. §103(a) as being unpatentable over Naeem et al. (US 5,846,884) in view of Hineman et al. (US 6,379,872 B1) and further in view of Chen et al. (US 6,080,662).

Appellants traverse the rejection of claim 3 and 12 over Naeem in view of Hineman and further in view of Chen. Appellants' arguments are incorporated by reference to the arguments above relating to rejection of claims 1, 2, 4-7, 13, 14, and 18-20.

Appellants' arguments are acknowledged and unpersuasive for the reasons given above in reference to claims 1, 2, 4-7, 13, 14, and 18-20.

C. Claims 8 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Naeem (US '884) in view of Hineman (US '872 B1) as applied to claim 1 above, and further in view of Angelopoulos et al. (US 6,316,167 B1). **NOTE: Claims 11 and 15 were inadvertently omitted in the header on page 6 of the Office Action of 8/24/2006.**

Appellants arguments with respect to claims 8 and 10 are incorporated by reference to the arguments above relating to rejection of claims 1, 2, 4-7, 13, 14, and 18-20.

Appellants' arguments are acknowledged and unpersuasive for the reasons given above in reference to claims 1, 2, 4-7, 13, 14, and 18-20.

Appellants traverse the rejection of claim 15 and argue the Final Office Action fails to provide any basis for the rejection of claim 15 in the body of the Final Office Action.

Appellants' argument is acknowledged and unpersuasive. It is clear from page 6 of the Final Office Action that claim 15 as well as claim 11 was inadvertently omitted from the heading of the rejection. However, the body of the Final Office Action discloses:

Naeem in view of Hineman differ in failing to teach wherein the ARC layer is of an organic material and wherein the photoresist mask is of a 193 or higher generation photoresist, **in claim 8**; and wherein the ARC layer is of an organic material and wherein the photoresist mask is of a 193 or higher generation photoresist and wherein the ARC open plasma etches the ARC with respect to the layer to be etched with a selectivity greater than 50:1, **in claims 10, 11, and 15**.

Angelopoulos discloses, "A broad aspect of the present invention is a resist structure comprising a resist on top of a vapor deposited RCHX film . . . wherein the optical and chemical properties of the RCHX films are tuned to (1) provide suitable optical properties at the appropriate wavelength (248 nm, 193 nm, 157 nm, 126 nm and extreme ultraviolet radiation) to function as an ARC (2) not negatively interact with the resist inducing residue, footing or undercutting and (3) provides good etch selectivity to the resist." (column 5, line 66 - column 6, line 10).

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Angelopoulos also teaches using the RCHX film as a replacement to conventional bottom ARC in a conventional stack as shown in FIG. 11 (column 7, lines 24-26).

Angelopoulos illustrates an ARC of an organic material having a photoresist mask of 193 nm or higher and the layer to be etching is silicon oxide is known.

Hence, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify Naeem in view of Hineman by using an ARC of an organic material having a photoresist mask of 193 nm or higher and the layer to be etching is silicon oxide for the purpose of providing good etch selectivity to the resist (Angelopoulos, column 6, line 5-10).

Since the combination of Naeem in view of Hineman and further in view of Angelopoulos teaches a similar method of etching as claimed by Appellants, then using the said combination in the same manner as the claimed invention would result the same wherein the ARC open plasma etches the ARC with respect to the layer to be etched with a selectivity greater than 50:1.

D. Claims 21, 22, 25, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Naeem (US '884) in view of Hineman et al. (US '872 B1). as applied to claims 1, 2, 4-7, 13, 14, and 18-20, above, and further in view of Hills et al. (US 6,217,786 B1).

As to claim 21, Appellants argue neither Hills nor the other references teach a lower electrode providing 0-1000 Watts at 27 MHz;

As to claim 22, Appellants argue Hill fails to teach etching the ARC layer in a temperature range from -20 to 40 C;

As to claims 25-26, Appellants argue Naeem's pressure of 2-10 mTorr and Hineman's pressure settings (column 5, lines 2-23) fall outside the 200 to 300 mTorr ranges of claims 25-26. Appellants further argue Hills teaches pressures ranges for etching an inorganic dielectric layer and not teach anything during the etching of the ARC layer.

Appellants arguments are acknowledged but unpersuasive because Hineman is relied upon to cure Naeem's and Hill's failure to specify a lower electrode of power of 0-1000 Watts at 27 MHz and 100-1000 Watts at 2MHz, **in claim 21;**

the temperature within said chamber is between -20 and 40°C, **in claim 22;** and
the pressure within said processing chamber at between 200 and 300 mTorr, **in claims 25 and 26.**

Hill shows a bottom power of 2 Hz within a range of 0-2500 watts (Table 1, see column 6, lines 42-54), which suggests as well as comprises Appellants' power at 0 watts; a chamber pressure that ranges from 10-250 mTorr, which encompasses Appellants' pressure within said processing chamber at between 200 and 300 mTorr; and top electrode temperature ranging from 0-60 C, which encompasses Appellants' the temperature within said chamber is between -20 and 40°C.

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Since Hills illustrates Appellants' specific process parameters are known, then it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify Naeem in view of Hineman by using Hills's process parameters for the purpose of achieving a substantially straight vertical profile of an opening in an oxide layer while maintaining critical dimension control (Hills, column 3, lines 36-41).

Further, Appellants' arguments as to Hill's failure to teach anything about (temperature) during the etching of the ARC layer, in claim 22 and pressure during the etching of the ARC layer, in claims 25 and 26, are unpersuasive because the said claims do not require nor specifically recite temperature and pressure at which the ARC layer is etched.

E. The rejection of claim 15.

It is noted that Appellants' arguments with respect of claim 15 is presented above in section C.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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ltue

June 18, 2007

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